

# Simply Universe

The Sky you know and beyond you don't!



Yash Sharma & Ishan Verma

With Devansh Kumar

ElectroStorms Publishing

ElectroStorms Publishing

India.

Published by ElectroStorms Publishing, 2021

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Dedicated to SHIBA INUs all over  
the world and also to the people  
who just bought it and will never  
read it.



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# *Foreword*

“A Foreword is a short introduction to the book, usually by a person other than the author. The purpose of the Foreword is to introduce the author or his/her work.”

But sadly we couldn’t find anyone who could write a forward to this book. Sad enough!

- *Yash Sharma*

## *FOREWORD*

# About The Authors

(Let us boast about ourselves but we'll not let you know  
that we have only written this section)

# Yash Sharma



Yash Sharma, an 11th-grade student presently studying at Sunbeam School Varuna Is a tech enthusiast and has been learning physics, mechanics, robotics, computing, and music production for as far back as 5 years. He has also authored Childlike terms of physics. He has his research papers “The train setback obstruction system” and “The fire extinguisher robot ‘febo’” Published in the international journal of engineering, applied science and technology & international research journal of engineering and technology respectively. Yash including his accomplice has been titled “Youngest duo to publish a research paper in a peer-reviewed journal” by Asia book of records and India book of records. He has also been honored with the ATL student innovator award and the inspire award by the Government of India.

# Ishan Verma



Ishan Verma, an 11th class student studying at Sunbeam School Varuna Varanasi is a science geek and loves to explore the unbounded limits of space. He is a karate red belt holder, a sprinter, and a state-level skater. Besides this, he is also a pianist and also trained at vocals. He is a gold medallist of the IGKO Olympiad and also has been awarded several times by the Manav Academy of Martial Arts. He had also won the 100-meter Sprint at Inter-School Athletic Meet 2018 (Zonal) with a timing of 11.9 seconds. He has also been recognized by "Subeh-e-Banaras" for his singing. Ishan wants to withstand and explore every field of a student's life and wants to be a perfect all-rounder. Rumour has spread that he is so qualified that he can be the next contender for PM. LOL!!!

Devansh Kumar



Devansh Kumar, born in 2005 in Varanasi, UP- India. He is an ambitious, self-driven, and proactive high schooler, currently studying at Sunbeam School Varuna.

The pleasing dark space and beautiful glowing stars in nights got Devansh fascinated with space. This interest led to some early exposure to reading about cosmology. He looks forward to being a learner and explorer of the vast subject of astrophysics and technology. He is a linguaphile too.

In *Simply Universe*, Devansh explores the vast space and the mind-boggling explanations behind it by introducing its theories. *Simply Universe* is the first book co-authored by Devansh Kumar.



# Acknowledgments

We would like to express Our deepest gratitude to our Principal Anupama Mishra ma'am, who provided carefully considered feedback and valuable comments. We would also like to thank all our teachers whose meticulous comments were an enormous help to us. We're also grateful for many students, friends, and people at Sunbeam School Varuna and for many of the learners who have given their valuable feedback for this material. We would also like to thank the team of Electrostorms for guiding us throughout. This book wouldn't have been possible without the help of Electrostorms.

- Yash, Ishan & Devansh







# *Prologue*

Life is so beautiful and peaceful. Isn't it? Nature, the animals, the humans, the ecosystem, the fundamental particles, our planet, Sun, Stars, various forces, etc.

All the things combine to generate life which we are living happily. But ever a thought strikes to your brain that "***How these all were made?***", "***How universe started?***", "***When it was started?***", "***What was its consequences?***", "***How big is it?***" and many more.....

We will be answering each one of your questions and would be telling amazing facts about fascinating space. So, fasten your seatbelt and get ready for an awesome space journey!!!

We'll be taking off after a quick disclaimer.

## *Disclaimer*

This book just gives you an overview of around 1% of the known universe and around 0.000000001% of the unknown universe. Though we aren't sure about this!!  
Readers Discretion is advised.

1.

The Big

Bang

Theory

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*Simply Universe*

**Bang-Bang!!**

## *The Birth*

So, let's go back in time around 13.8 billion years ago. All our universe was existing in an atom-sized particle. Could you imagine what we can see and feel was all existing in this energy particle? Awesome, isn't it? There was no existence of time then. All our universe was just going to start. Due to an unknown phenomenon, the universe which was contractile in a particle came into existence by a very big explosion. This explosion is known as "**The Big Bang**". The time came into existence or we can say the universal time was started as soon as the bang occurred. So, our universe is **13.8 billion years** old and increasing. Quite old.



*Meme –The Big Bang Explosion*

## *Simply Universe*

In the  **$10^{-35}$  part of a second after explosion**, the universe rapidly expanded to the size of a football, this stage is called **inflation**, that universe of football was so hot and dense which containing immense energy in the form of particles. It gave birth to two types of particles: **Matter** and **Anti-matter**, they both were opposite of each other so they were canceling each other out. In the battle of particles, **Matter won** because fortunately at the time of birth their number was more than Anti-Matter so today what we see is matter (what if anti-matter had won that battle?). Then, after  **$10^{-9}$  part of the second** the four fundamental laws of nature came to force which are:

- **Strong Nuclear Force**

It is the strongest force of nature and acts in the nucleus between neutron-neutron, proton-proton, and neutron-proton. In the nucleus, proton-proton bonds together despite having a positive charge and we know like charges repel each other but this is a mystery to date as that how are they bonded together!! Enjoy the meme on the next page.....(This book is full of memes)



A new way of visualizing the atomic nucleus

*Meme –Strong nuclear force*

- **Weak Nuclear Force**

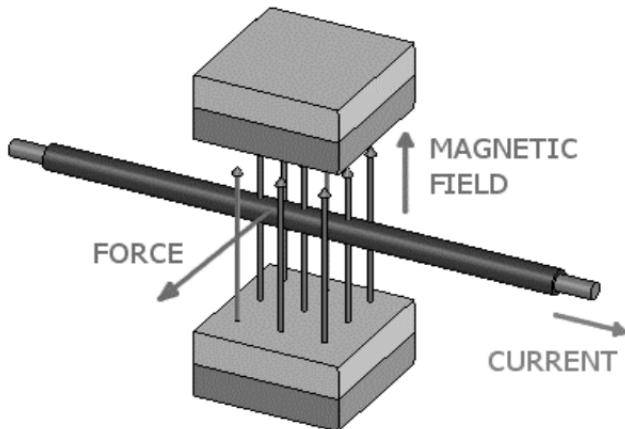
It is the rarest force of all four and acts between neutrino & other particles. Found only in  $\beta$ -decay\*. It is a very short-range force, when I say short it means short (acts in  $10^{-14}$  m to  $10^{-15}$  m). It is also called weak interaction. I know you also have a weak interaction with your crush!! Same here sadly!

---

**$\beta$ -decay**— A type of radioactive decay process in which an electron or positron and neutrino is emitted from a nucleus

- ***Electromagnetic Force***

It is a force that acts between electrically charged particles. It is a strong force and is effective in the long range. This force is both attractive and repulsive and doesn't require any medium. The electromagnetic force consists of two terms -Electro and magnetic which suggests that this force is the combination of all the electrical and magnetic forces.



*Fig –Electromagnetic force*

- ***Gravitational Force***

It is a force act between the masses attract each other in our universe due to this force

## *Simply Universe*

(this was the force which was discovered by Sir Isaac Newton because of that hell apple and gave us a lot to study ☹). It is a very long-range force and doesn't require any medium to act on. It is the weakest force of all four.

$$\text{Formula, } \mathbf{F} = \frac{G \cdot M \cdot m}{r^2}$$

Now let's come on to the big bang, till the time, the universe had expanded in a diameter of 1 billion kilometres so the temperature begins to decrease comparatively. Now  $10^{-6}$  second has been passed and quarks begin to combine to form hydrons (like proton and neutron) and leptons (like electrons). After 1 second of the explosion, the universe has expanded to a diameter of whooping 100 billion kilometres so it is cooled down comparatively. But not so cool and not so quick, the Big Bang blast was so tremendously big that the temperature reached **1,000,000,000,000** degrees Celsius at just a tiny fraction of a second (still not as hot as the tea made by our moms LOL!!). The energy flying in all directions at the speed of light which is **a million times faster than the hydrogen bomb**. The blast releasing an enormous amount of energy which cooled down over millions of years. That much powerful our birth was!! You must be thinking about how and who proved the Big Bang theory to be almost true? Its credit goes to **Edwin Hubble**. In 1926, while developing a

## *Simply Universe*

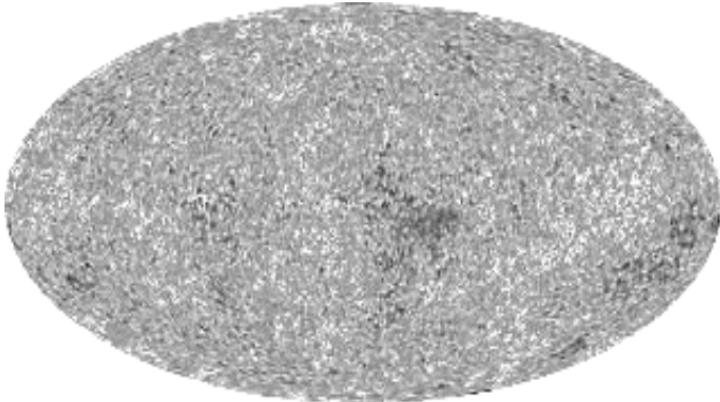
classification system for galaxies, Hubble discovered an added fact: Almost every galaxy he observed appeared moving away from the Earth. He knew this because the light coming from the galaxies exhibited a red shift. Light waves from distant galaxies get stretched by the expansion of the universe on their way to Earth (Doppler's Effect). Hence, he concluded that the universe is expanding! (We'll elaborate on **Expanding Universe** in a later chapter). And the expanding universe must once have been smaller and at one place billions of years ago. This is like rewinding a video so you can get its starting point. Earlier to this, many predictions were also made that all galaxies are getting far away from each other at an increasing rate but Hubble's contribution was significant.

Finally, in 1964, we got the biggest evidence of the big bang which was **cosmic microwave background radiation** (Not the kitchen microwave). Now as we know the big bang possibly states that the universe was extremely hot in the beginning stages, the cosmic microwave radiation is a type of left-over electromagnetic radiation from the big bang



## *Simply Universe*

which validates that the universe was extremely hot at the time of the big bang for true and these **glowing radiations** are the proof of it.



*Fig –Cosmic microwave background radiation*

It was an accidental discovery but this discovery along with other observations made the big bang a widely accepted theory. After advanced technology like **The Hubble Space Telescope** (named after Edwin Hubble) gave us more proof about the big bang and also gave a whole new image of our universe.

### **Fun Fact**

Big Bang was so enormous but had loudness of only 110dB LOL!

*Simply Universe*

2.

Matter

And

Antimatter

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*Simply Universe*

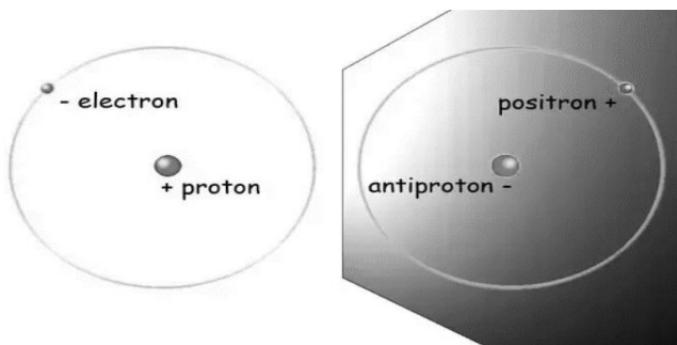
*Choose your Side!!*

Before starting this topic, we have to first understand **Quantum Theory** (I know you related this to Avengers Endgame).

It is a theory of modern physics that explains the nature and behavior of matter and energy on the atomic and sub-atomic levels. It describes how and why matter and forms of energy show different behavior. This is called Quantum Theory. So, almost 70 years before, scientists were researching quantum theory and these all were done by mathematics, lots of mathematics (by the way I love mathematics). One day, a physicist named Paul Dirac realized that if  $x^2 = 4$  then result would be +2 and -2. So, concluding this equation, he assumed +2 as matter so a question raised that if +2 is matter and -2 is opposite of +2 then an opposite of matter must be there so he assumed -2 as anti-matter. Properties of matter and anti-matter are also just opposite as their name, atoms of matter as we all know are mainly made up of protons and electrons in which protons carry a positive charge and electron charge carry a negative charge but the case of anti-matter is different, atoms of anti-matter if made up of **antiproton** and **positron** in which antiproton carry a

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negative charge and positron carry a positive charge. In matter, positive charge is at the center of the nucleus, and negative charge is in the forms of electrons revolving in orbits in the atoms of matter but in the anti-matter, the negative charge is at the center of the nucleus in the form of antiprotons and positive charge revolves in orbits in the form of the positron.



*Fig*

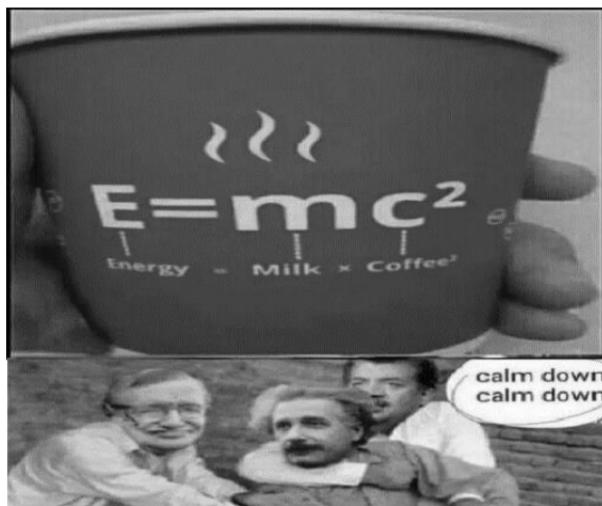
That's freaking miraculous man. Now because they have opposite properties from each other, do you know what happens when they meet?

The answer is KABOOM.

## Simply Universe

Whenever Matter and Antimatter both come in contact, they release a high amount of Gamma rays\* and cancel each other out leaving only Gamma radiation. This process is called **Annihilation** and energy is left behind because mass can be converted into energy. Ass Einstein formulated it in his theory of relativity i.e.,

$$e = mc^2$$



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**Gamma Rays** – An electromagnetic wave of very high energy, very high frequency, and short wavelengths. Gamma rays are generated in a process called gamma decay.

## *Simply Universe*

Now a question comes to mind that if anti-matter theory is real then why are we unable to see anti-matter in our surroundings just like we can see matter? There could be only one possible answer to it, Anti-matter has been already destroyed from our universe. Yes, it is possibly destroyed. The rivalry between matter and anti-matter is too old that it dates back to the big bang explosion. A quick reference was given in the big bang chapter, when the big bang occurred it gave birth to two types of particles which were matter and anti-matter. Due to opposite properties, matter and anti-matter collapsed with each other canceling each other out. In the end, matter particles left as theories say that the big bang created matter particles more than anti-matter particles. The reason for this is still **unknown**. So, the conclusion is that anti-matter doesn't exist.

But stop there, scientists are in the race of making anti-matter particles so they can open up all mysteries related to it. **CERN** – Centre for European Nuclear Research is researching anti-matter for the last few decades. This anti-matter factory makes anti-hydrogen which is the anti-

## *Simply Universe*

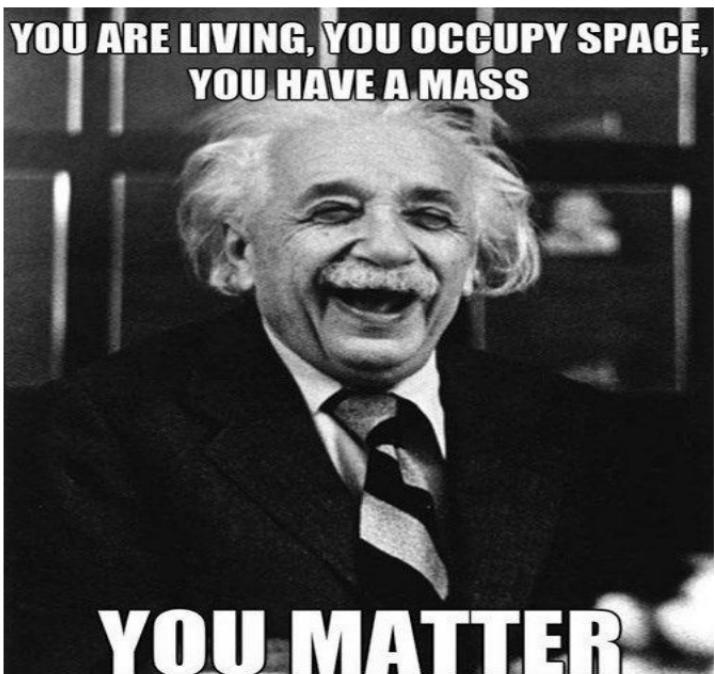
matter version of hydrogen. They make it by **LHC** – Large Hadron Collider.

We know enough about hydrogen element as it is NOT so complex element and also the root of our life is due to water and it is made up of hydrogen so researchers wanted to know how anti-hydrogen and hydrogen are different from each other. In all these processes one thing is so important that anti-matter should not come into contact with any matter particle, **neither with the air particle nor with the container**. To make anti-matter particles stable, scientists use **magnetic fields and a lot of energy**. And once they can capture this then they can unfold some secrets of our universe. Scientists trapped anti-matter atoms for the first on 17 November 2011 but soon after they knew how to trap more than a dozen of anti-matter particles multiple times. But then too, anti-matter doesn't stay stable for a long period instead it annihilates and gets destroyed. To date, CERN has made only 10 nano grams of anti-matter which can power an electric bulb for only 4 hours but the energy used to make these particles are a billion times more than the power required by an electric bulb!

## *Simply Universe*

Although anti-matter is the opposite of matter it's also similar to matter in some aspects. Anti-matter is not a kind of magic, gravity works on it just as it works on the matter. not just gravity, there are possibilities that all forces can have the same action on anti-matter as they have on the matter. Let me take an example, if I made a building of anti-matter then that building would be as same as the building made up of matter but the only difference is that to live in that building, I must also be made up of anti-matter otherwise matter – anti-matter KAAABOOM (LOL!!). Ok let's explain this with another analogy, assume in the battle of matter and anti-matter, anti-matter had won and left out then our universe would have gone as normal as the case of matter, then what we see and feel would have been made up of anti-matter. There is also a possibility that we would have been stating anti-matter as matter and matter as anti-matter. In the conclusion, what are the uses of anti-matter in our life? Anti-matter can be used to diagnose cancer by the technique called **PET** – Positron Emission Tomography, also anti-matter is a brilliant source of energy and it can replace **nuclear reactors** from present-day scenario to anti-matter

**reactors, we can also make spacecraft which can travel at almost the speed of light** (Isn't this phenomenal)!! One thing is confirmed that the day humans will be able to use anti-matter as a source of energy, we will be unlocking the new secrets of the universe and will be conquering the new heights of it.



*Simply Universe*

3.

Dark  
(Energy  
& Matter)

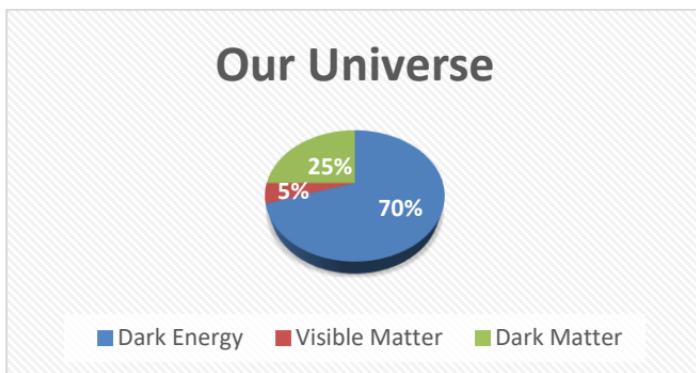
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## Simply Universe

“In terms of the most astonishing fact about which we know nothing, there is dark matter and dark energy. We do not know what either of them is. Everything we know and love about the universe and all the laws of physics as they apply, apply to four percent of the universe. That is stunning.”

-Neil deGrasse Tyson

A huge amount of our universe is made of something entirely different from you and me, Stardust but interesting thing is that all this what we can see could not have even existed without what we cannot see. what we can see is just 5% of the total mass in the universe, it includes the galaxies, the planets, the stars the Stardust the gas, and us too. The rest 70% is considered as dark energy and 25% as dark matter, it does not emit or absorbs any sort of light, but their existence is concluded because they influence what we can see.



*Pie-Chart*

## *The Evidence-*

What even makes us think about dark matter and dark energy? In the 1920s Edward Hubble used the biggest telescope of his time to observe faraway galaxies, he found something very interesting that the light coming from these faraway galaxies was red-shifted which meant that those galaxies were moving away from us, when we stand at the roadside you hear the ambulance with a variation in its pitch this does not happen because the siren's note is changing, it is because the ambulance is moving relative to us, same happens when a source of light (here galaxies) move away from us it's wavelength increases or gets stretched and as we know red light is having a higher relative wavelength, we generally observe this red shift in the visible region of electromagnetic radiation.

It has been proved that matter is created and destroyed continuously in our universe but at the moment of Big Bang everything was so fast that matter didn't got any time to get destroyed and it was only created, this give birth to fundamental gravitational force, when the masses came close enough they form galaxies and then the stars

## *Simply Universe*

were created and then our planets, to actually gravity played one of the most important roles and holding us together, but still there is a more mysterious thing out there, when we study Galaxy we observe that they are speeding too fast to hold themselves together, stars at the edge of galaxies should travel much slower than those near the center where the galaxies visible matter is concentrated, what observations show that the speed of the ones at the edge and the one said the center have negligible differences, this was a puzzling result, here comes dark matter into the picture, according to physicists there must be some gravity produced by matter that we just can't see or detect, basically without dark matter there won't be any galaxies the stars would have flown away into the outer space without it, and without stars there would be no planets and without planners there would be no us.

Dark matter can also be explained with the optical illusions we observe on the outer space, light from distant galaxies gets distorted and magnified buy some invisible massive volume of dark matter, basically light avoids going through dark matter-this phenomena is known as gravitational lensing.

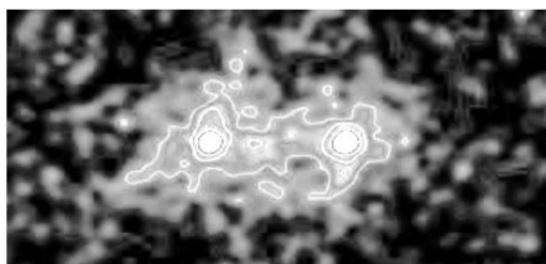
## *Simply Universe*

We have been hunting for dark matter for decades now, scientists define dark matter as the unseen component of the universe, which is invisible, non-baryonic matter hypothesized to explain the phenomena including gravitational lensing and galactic rotational curves. As of now the existence of any dark matter in our solar system remains as mysterious as its presence everywhere else. Another thing which fascinates me the most about dark matter is its speed some physicists believe that the mass after dark matter is half that of a photon and it travels with a speed faster than the speed of light, but some say that since darkness is the absence of light and that light travels with the fastest speed possible for a physical object, darkness or say dark matter travels with the same speed of light.

Physicist Michio Kaku quotes – “However, one new theory says that dark matter may be ordinary matter in a parallel universe. If a galaxy is hovering above in another dimension, we would not be able to see it. It would be invisible, yet we would feel its gravity. Hence, it might explain dark matter.” It is thought to be composed of a new exotic particle (axion or sterile neutrino or neutralino...), but there is a

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very broad range of possible masses, from the mass of a proton to the mass of about 100 suns. The density of dark matter in the solar neighbourhood, Alpha centauri is considered to average about 1/3 of a proton-equivalent per cubic centimetre. Scientists have lots of way for hunting dark matter, one of them is a sensitive underground detector (LZ Experiment) waiting for a dark matter to pass through our solar system and earth so that it good detect its trace. Another way is fermis gamma rays Space Telescope, it is believed theoretically that if two dark matter scolicite they would produce special high energy gamma rays that would be detected by our telescope in outer space. The third way we are trying to find it out is by creating it by colliding particles together and looking for what happens, this is done in the large Hadron Collider in Switzerland.



*Fig –First ever image of dark matter*

## *Dark energy and the Expanding Universe-*

In the late 1990s, Edward Hubble discovers the expanding universe with the concept of red shift as we talked about earlier. he noticed that the further away the galaxy was the redder shifted it became and after a detailed analysis of different redshifts he concluded that the galaxies were flying away from each other, and the universe was growing in size. Later in 1998, it was predicted that with time this speed of expansion what slow down and gradually stop or even start contracting. but then when two teams tried to measure the deacceleration rate of this expansion, they ironically ended up concluding that our universe is actually speeding up i.e., it is expanding in accelerated manner. Now scientists think that this accelerated expansion is the result of some quantum fluctuations in the outer space which is a kind of repulsive force generated by these fluctuations, scientists called this mysterious force dark energy which seems to be growing more stronger as our universe expands. Some physicists even say that dark energy could be the 6th fundamental force of our universe

## *Simply Universe*

which was hidden from us until the last two decades.

When Albert Einstein was formalizing his general relativity theory to fit the equation with the notion of the static universe he added a cosmic constant do it, when the theory of expanding universe was considered he called this cosmological constant as his biggest blunder but now we understand how great he was for adding this cosmological constant to his equation, adding in dark energy add cosmological constant could very well explain how space and time are being stretched apart and are related. but still, to this time dark energy has no explanation of its existence, for us, it just exists for no reason but has a great impact on our existence. So dark matter attracts, and dark energy repels. While dark matter pulls matter inward, dark energy pushes it outward. Also, dark energy shows itself only on the largest cosmological scale but dark matter shows us its influence on every galaxy out there.

For me dark matter and dark energy seem to be the most mysterious thing out there, just like the big bang: everything from literally nothing,

## *Simply Universe*

these dark stuffs are everywhere but nowhere. It could be passing through you right now, but no one knows, anything about its effect. Till now there only a few things which are known about it:

1. There is something out there.
2. It is in large quantities
3. We cannot see it.
4. It is the reason of our existence and holding us together but at the same time expanding our space.

*Simply Universe*

4.

The  
Black  
Holes

---

Black holes, the most mysterious and wondrous object in our universe.

It consumes matter, sucks it, crushes it beyond existence. At the same time, it may have a whole new universe within it!!

In the year 2020, three scientists **Roger Penrose, Reinhard Genzel, and Andrea Ghez**, shared the Nobel Prize in physics for their discoveries about one of the most exotic phenomena in the universe, the black hole. The award was for spotting a black hole at the centre of our milky way galaxy. In 1916 Einstein gave the general theory of relativity and predicted the existence of something like this, after his death Stephen Hawking and Roger Penrose together worked and proved that its existence is possible and here, we are today, after 3 decades of observation Reinhard and Andrea concluded that there is a black hole named **Sagittarius- A**.

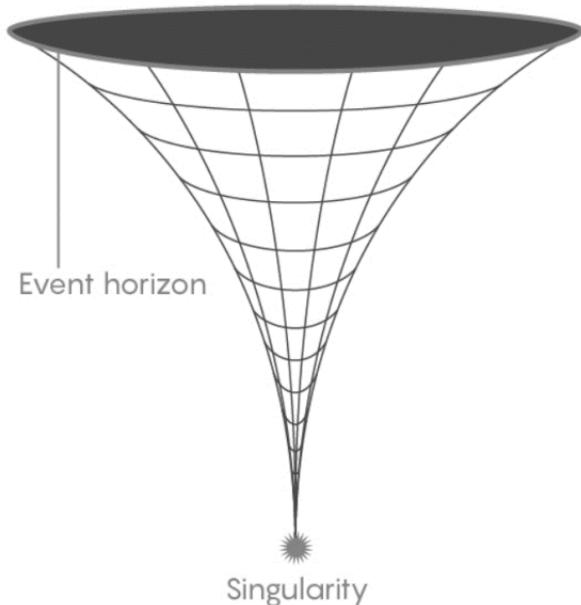
## ***What is a “Black Hole”?***

The black hole is a region of spacetime having extremely intense gravity from which nothing can escape. Even electromagnetic radiation such as light cannot escape a black hole. To escape earth's gravity a spaceship or any other object needs to be traveling at a speed greater than 11km/sec, speed of light is  $3 * 10^8$  m/sec, just imagine the gravity of the black hole which is not

## *Simply Universe*

allowing even light to escape its gravity. A Blackhole has three layers i.e., the outer and inner event horizon, and the singularity.

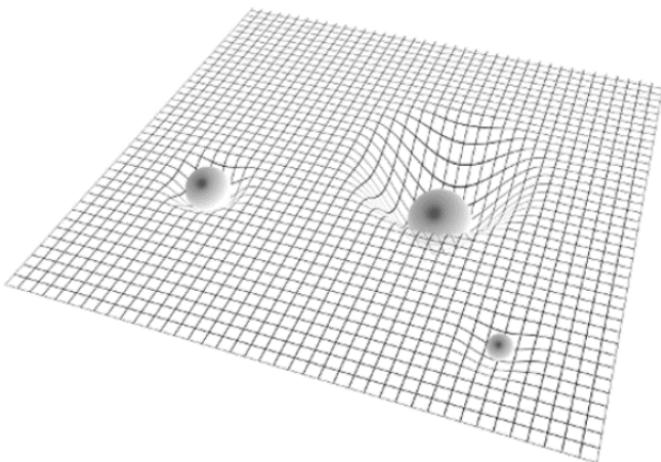
The event horizon of a black hole is the boundary around the mouth of the black hole, past which light cannot escape. Once a particle crosses the event horizon, it cannot leave. Gravity is constant across the event horizon. The inner region of a black hole, where the object's mass lies, is known as its singularity, the single point in space-time where the mass of the black hole is concentrated.



## *Simply Universe*

*Fig –Singularity and Event horizon of a black hole*

Let's understand the picture. According to the theory of general relativity, space-time bends proportionally to the density of the object, ex. Since our sun is denser than earth it bends space-time more than how much our earth does. A black hole is infinitely dense resulting in the space-time bending into the singularity.



*Fig –Bending of space-time*

### *How is a Black Hole formed?*

There are lots of stars in our universe, each with varying mass. Blackhole formation will take us to consider the mass of other stars relative to our

## *Simply Universe*

sun. a star is formed of clouds of gas and dust, known as nebulae. Nuclear reactions take place at the centre or core of the stars which provide the energy to make them glow brightly for billions of years. The lifetime of a star will depend on its size. Very large, massive stars burn their fuel faster than smaller stars and last only for a few hundred thousand years, huh! Still a lot. Smaller stars will last for several billion years because they burn their fuel very slowly. With time, the hydrogen fuel that provides energy to the nuclear reactions within stars will start getting over, and they will enter the final phases of their lifetime. Over time, they will start expanding, get cooler and change their colour to become red giants. The path they follow after that depends on the mass of the star. Small stars, like the Sun, will undergo a relatively peaceful and beautiful death that sees them pass through a planetary nebula phase to become a white dwarf, which slowly cools down. Larger stars, on the other hand, will experience a most energetic and violent end, which will see their remains scattered about the cosmos in an enormous explosion, called a supernova. Once the dust clears, the only thing remaining will be a very

## *Simply Universe*

dense star (just one proton of it would weigh about the earth) known as a neutron star. If the star which explodes is large, it will form a black hole.

Now there is something more, if a white dwarf has a mass less than 1.4 times the mass of our sun then it will stay a white dwarf forever, but a star that exceeds this mass will end its life in the violent explosions: a supernova, which would lead to either a black hole or a neutron star.

**Subramanyam Chandrashekhar**, an Indian-American astrophysicist was the one to give this limit relative to the mass of our sun, which told us white dwarf can end up as a black hole.

Scientists have theorized several different kinds of black holes, with Steller and supermassive black holes being the most common. Stellar black holes when massive stars die and collapse. There are roughly 10 to 20 times massive than our sun and scatter throughout the universe. There could be millions of these kinds of black holes in our milky way alone. Supermassive black holes are giants by comparison measuring millions, even billions of times massive than our sun. scientists can only

## *Simply Universe*

guess how they form but we do know that they exist in the centre of every galaxy, including ours. Sagittarius A is the one we have whose mass is roughly 4 million times the sun of our solar system and diameter of about the same distance between sun and earth.

Because black holes are invisible, the only way to detect and study them is by observing their effect on nearby matter. This includes an accretion disk, a disk of particles that form when gases fall towards the black hole, and quasars (more about quasars in a later chapter), jets of particles that blast out of these supermassive black holes.

**\*\*When two black holes collide, the diameter of the resultant black hole is greater than the sum of diameters of the two initial black holes.**

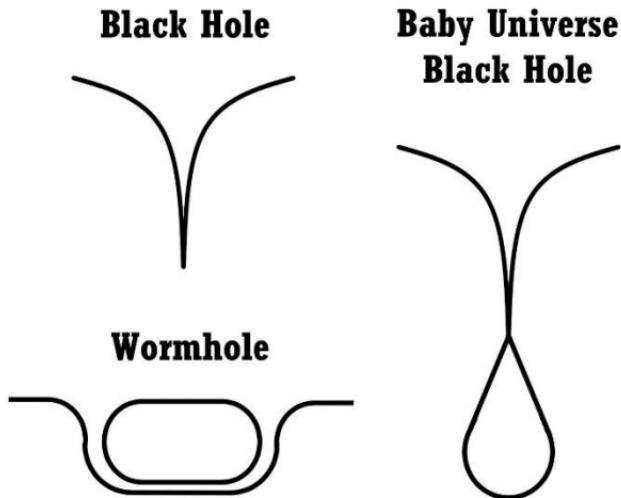
## *What is after “Singularity”?*

### Baby Universe

One possibility of what is after singularity may involve the idea of putting the information somewhere or storing it for later, which would ensure physics is not broken. Till now the most fascinating theory or idea is that the information goes into a Baby Universe. This is weird, isn't it! The idea is that the black holes form Einstein-Rosen Bridges to a separate baby Universe, which is smaller in size, where the information is stored. So, this is neglecting the idea that the information going into the black hole gets destroyed. For some scientists, black holes are not just a deep dent in spacetime but are a bridge between two separate places, or say universes. The problem with this is that the bridge created between the two places is so skinny that matter cannot travel through it, it would take an enormous amount of energy and something that opposes the gravity to widen it up so that you could push something through it. But rather than acting as a wormhole and having the bridge go

## *Simply Universe*

to another location, a baby Universe would instead create a separate small universe inside the black hole.



*Fig –Baby Universe/ Black hole/ Wormhole*

We know that matter cannot travel into the new Universe but information can probably do so. This way, the baby Universe acts as an information collector, which means that an entropy (entropy is a measure of uncertainty or randomness) increase can happen and information can be preserved even after it falls into the black hole.

## *Simply Universe*

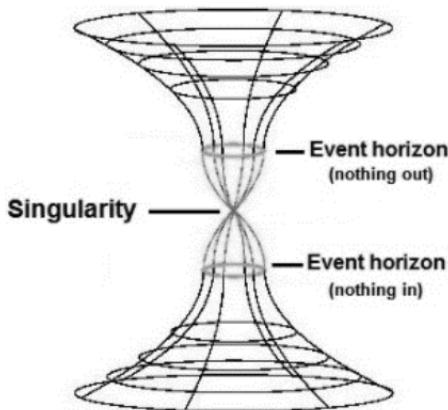
The math here checks out, at least with some types of General Relativity. So, there is at least some minor possibility that black holes create a small baby Universe full of the information that they consume. Some of the calculations suggest that even matter could pass through, which means that the baby Universe might be small, but a full-fledged Universe, which means that they could be just some identical part from our existence. So how do we know if we are outside the baby Universe or inside it? We do not! **It is also possible that we could be living inside a black hole!**

## HOW FASCINATING  
IS THAT ##

## White Hole

What if, rather than making a little Universe, black holes are just wormholes that spew stuff out in a different part of our Universe? This idea is known as a white hole which is the theoretical opposite of a black hole.

## **Black Hole**



## **White Hole**

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*Fig –Worm-Black-White Hole*

This means that the information falling into a black hole gets spewed out somewhere else in the Universe as light with the information encoded on it. This means that entropy can increase and information is preserved.

## What if you fall into a black hole?

### “BLACK HOLES DON’T SUCK”

First, let's clear up a common misconception. Black holes get a bad reputation for sucking in their surroundings, like some sort of cosmic vacuum cleaner. In reality, the gravitational pull of a black hole is the same as that for a regular star—just a lot stronger. So, it simply attracts matters because of the gravitational force of attraction.

This means that the information falling into a black hole gets spewed out somewhere else in the Universe as light with the information encoded on it. This means that entropy can increase and information is preserved. Whereas in a supermassive black hole the difference between the force experienced by your leg and your head is negligible, which will not tear you apart on the way at least but will make you 1 with the black hole at the singularity.

## *Simply Universe*

### *What would be observed while falling into a black hole?*

As soon as you come near to the event horizon the person watching you from a far distance would be seeing you slowed down and stopped at that point and slowly fading away, but slow. What is happening at this time is that you have already crossed the event horizon and now there is no returning. As soon as you turn your face you will be able to see that the universe outside the event horizon is moving fast and things are changing at an accelerating pace, you will be able to see the whole future of the universe until you reach the singularity.

### *What will happen to you?*

Depending on whether the black hole is supermassive or small, either you will die or disappear on the way or on reaching singularity, but you will no longer exist as a human. Your quantum information will disappear, which means even if a black hole dies and releases all information it had in it, no advanced technology will be able to identify that the atom or the molecule or the radiation belonged to you. It

## *Simply Universe*

doesn't mean that people will forget that you existed but will not be able to prove that you existed. The black hole messes with time my friend, even if you return from a near point of a black hole, you might have missed World War 3 and probably your girlfriend's wedding.

## *Hawking Radiation?*

One of the greatest astrophysicists of all time, Sir Stephen Hawking, claimed something that is not what blackholes usually do, but it surprises us every time. Hawking radiation is the description of some hypothetical particles formed by a black hole's boundary or say horizon. This radiation implies that a black hole has a temperature that is inversely proportional to its mass. Or simply, the smaller a region is, the warmer it should glow. But till now it has never been directly observed, Hawking radiation is a prediction supported by combined models of general relativity and quantum mechanics. It was published in 1974, titled **Black hole explosions?** arguing for their existence.

5.

# *Dimensions*

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*Simply Universe*

## *Simply Universe*

Most of the time the idea of dimensions is misunderstood with someplace where you can mystically go, but for a physicist or mathematician, it is just like the direction an extra direction in which one can travel. Let's start with a simple question, what is your location on the globe? You would simply tell me the latitudes and longitudes of your place, right! Dimensions are exactly the same thing, you and I live in a three-dimensional world, you can go left-right, backward forward, upwards – downwards, this makes us 3-dimensional beings. But for physicists and mathematicians, there exist some extra dimensions where the laws of physics may be different. Let us begin our journey and understand what dimensions mean.

Imagine a single dot, this is the Zero dimension, living in this dimension will not have any positions and not even distance. Now join two dots and make a line out of it, this is a one-dimensional plane, here you get only a single direction- one can move either forward or backward, this is actually like the axes we study in our classes, so let's take one dimension as X-axis, after taking a reference point you can tell the position with a single unit. For understanding

## *Simply Universe*

Two-dimensional system just add the Y-axis on the X-axis in a perpendicular manner and you get a plane, this is like an ant walking on a sheet of paper, it can go anywhere on the plane but not upwards or downward until it falls after reaching the edge, but don't misunderstand 2D with any edge, it is just a plane with no edge, in this, for determining something's position you have to determine it both x and y-axis coordinates. And then comes our third dimensional, just add another axis perpendicular to both the axes of two dimensions, and then we get our Z-axis, which means the depth is added to make a 2D square into a 3D cube, here you can go in all the possible directions and for determining a position one has to give coordinates of all the three axes.

But now try to add other axes perpendicular to X, Y, and Z axes. You can't, but physicists have theoretically determined extra dimensions. The first three dimensions are so easy to understand and imagine but what about something we have never seen and can hardly calculate existence mathematically. The scientists have done it and mathematically after there are 11 dimensions, the other dimensions are really

## *Simply Universe*

unstable and the particles in it would simply not exist or would keep collapsing. It is impossible for a 1-dimensional creature to see a 2dimensional world similarly it's impossible for a 2-dimensional creature to see a 3dimensional world. A dimensional world cannot contain a 2D object similarly 2dimensional world cannot contain a 3D object and that goes the same with 3D and 4D worlds. Imagine a crystal broken and shattered over a 2-dimensional surface and now some creatures living in this dimension try to repair the crystal but were able to make it into two chunks, a top part, and the lower part, now whatever they do they can't assemble these two parts without someone from the third dimension keeps these two chunks one above another so basically it has to travel from a higher dimension to get back into its original shape, similarly, according to physicists our universe is horribly broken into pieces and scattered in three-dimensional surface, but at the beginning of time when The Big Bang occurred just before this moment, there was perfection in the existence of all the forces and atoms. today we have different branches of science the quantum physics the Newtonian physics the theory of relativity the

## *Simply Universe*

general relativity and many more but what we observe is that all of this science does not fit together and give a certain result, all of it is so uncertain. Take for example electromagnetism and the gravitational force these two fundamental forces have a massive difference in their scale, gravitational forces are very weak. but just before the moment of the Big Bang, each of these forces had a similar scale. So where has this most of the scale of gravitational force disappeared, physicists, say that the gravitational force is the only force which has been able to travel among different dimensions? This makes physicists more interested in the topic of extra dimensions in which theoretically some of these forces and most of the physics would be interconnected and satisfy each aspect of laws with one another.

***Now, where are these extra dimensions?***

Take smoke, it diffuses in all the three dimensions and all the directions in the room, but it does not disappear, it does not close in another dimension, or take an atom even it

## *Simply Universe*

doesn't wipe out into any higher dimension. Therefore, these higher dimensions must be smaller than the small and even smaller than the atom otherwise our whole universe would have drifted slowly into another dimension. There are many theories about the existence of these dimensions but what I prefer the most convenient is that our surrounding has these extra dimensions already but we are not able to observe these because of its size, understand it in a manner like you rolled a sheet of paper into a 1-dimensional figure and then with a microscope you observe this rolled-up sheet so you will definitely be able to recognize that it is actually a 2-dimensional plane which has been rolled up.

### *The 4th dimension: TIME*

The most discussed of the higher dimensions is the fourth dimension, majority of the scientists say that the 4th dimension can probably be time. That means all our science fiction fantasies of time travel could be possible in the fourth dimension where you can not only travel along the height width and length but also travel forward or backward in time. And taking time as a fourth dimension actually is an appropriate

## *Simply Universe*

thing because imagine your friend asking you to meet him at 8:00 PM, the very next question you will ask him is “where do we have to meet” and take another case as he asked you to meet At the CCD, now your very next question will be “when”. So what we see is that time and position these two things are fundamental but can't be assured without each other. Dr. Neil deGrasse Tyson assures us that we are not the prisoners of the three dimensions, but we actually move in the fourth dimension as well. if someone asked me is time travel possible I simply reply as yes, yesterday I travelled 24 hours in future. He also says that even we are not the prisoner of the three dimensions, but we are the prisoners of present because the fourth dimension of time This Is Us alone from past towards the future, we basically have no freedom to move between them in our three-dimensional world. Even Einstein's theory of general relativity has been proven true which suggests that the space and the time are not two separate things but rather related to each other and effect in any one of these will show a change in another this is called the space time continuum. Let's understand in the simple way we all understand that our space

## *Simply Universe*

is curved from place to place due to gravity So what general theory of relativity says is that all these curves in space actually cause a deviation in the flow of time from one point to another. In our world, time travel into future is possible with two ways either you travel in a spacecraft with the speed slightly lower than the speed of light or just over around the black hole for a moment and then when you come back you will be in the future, bot time travel into past is most probably not possible according to most of the scientists. but when we consider time is the 4th dimension in any other world all this changes, in a world with hold dimension as time people will have no concept of past present and future, for them time will be simply another physical quantity which can be touched and felt. the idea of our existence as a 4-dimensional creature is still a debatable topic among physicists, but taking knowledge and technological advancements human have right now with us it can be assumed that time can be a full dimensional physical quantity which we are not able to control in our three dimensional world. We pick a tesseract as what 4th dimensional objects would look like, we humans can never see a fourth dimensional world

## *Simply Universe*

because in case we are able to do so the universe will start working in a very mysterious and confusing way for both the worlds with respect to each other the flow of time will be altered the stability of atoms in our universe will be affected and many other things which could even lead the collision of these dimensions and no one knows what could happen after that. a big question that comes to our mind is that add these higher dimensions accessible to us or how can we access these? so the scientists theoretically have assume that there are portals like the wormholes in different parts of our universe that act as a door to higher or lower dimensional worlds, this is what we call the multiverse, but as we have studied earlier multiverse theory itself is not proven or even questioned by other scientists. No one knows what the future has for us! 200 to 300 years ago the concept of black holes and Quasars were only sort of imagination for us but still we got them right, so I do not think that traveling in time will be impossible thing in future of human civilization, let's not leave the hope at least!

## *String theory*

## *Simply Universe*

nowadays it's the most favorite topic for theoretical physicists because it's a hope that someday this string theory will be able to explain the relation between quantum physics and atomic physics and will finally let us be able to connect our broken world and give 100% true system of how the universe works. Let's understand the sting theory in a brief way, take water for example and zoom it to the molecular level you see two oxygen atoms and hydrogen atom now zoom to the atomic level here you see the nucleus with electrons revolving around it in fixed energy levels, now zoom more further into the nucleus and then into the neutron, here you find quarks, basically, here the conventional idea stops, but here the string theory comes along and suggests that inside these particles there exist a filament, a string like a filament which is just like the string on the guitar which vibrates, similarly the quarks are nothing but vibrating filaments in a single pattern, the electron also is a vibrating filament with a different pattern and every other particle, the neutron, the proton, the atom, the molecule, all are string-like filaments with their specific pattern of vibrations. the multiverse theory can also be proven correct with the help

## *Simply Universe*

of string theory, it suggests that our universe has a vibrating boundary, and similarly there exist other universes with different vibrating boundaries which can be thought of as bubbles so when they collide, they could probably become a single universe, or a universe could probably split into two universes, and that's how The Big Bang would have probably happened. String theory has also held scientists like Stephen Hawking and many others to calculate the ways of traveling through a wormhole, which would lead us to another dimensional world. But have you ever thought of why do we need to find ways to access a worm hole that could lead us to another dimensional world? the fact is that somewhere in the future the universe will lead to its end and then be humans and other intelligent civilizations of the universe will have to travel into another universe, but how when our universe ends? let's talk about this in the next chapter.

6.1

Our  
solar  
system

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## Simply Universe

I hope you enjoyed the previous chapter. Didn't you?? Not a problem. Try to enjoy this one because this chapter is related to your surrounding (our vast neighbourhood). Though in this part we will just discuss about the sun. planets will be discussed in next part

So, let's start!

Thanks, mom, for the coffee and also for saying that the previous chapter was boring!!

## *Simply Universe*

The solar system ah..... (let me remember) ...Okay So, the solar system consists of the sun and various other celestial bodies gravitationally attached to the sun. The gravitational attraction is just a force of attraction between bodies having either mass or energy. The nine planets oh sorry, the eight planets (some people just kicked Pluto out of the list of planets) along with their known moons, five dwarf planets i.e., Pluto -the kicked one, Eris, Ceres, Makemake and Haumea, asteroids, comets, space dust and billions of small bodies orbit the sun. Beyond our planetary group aka solar system, there is a greater number of planets than the number of grains of sand on the planet on which we live. Do you know that the planet on which we live is named 'Earth'? We will talk about earth in a later part. Up until now, we have found a large number of planetary systems orbiting other stars in our milky way galaxy.

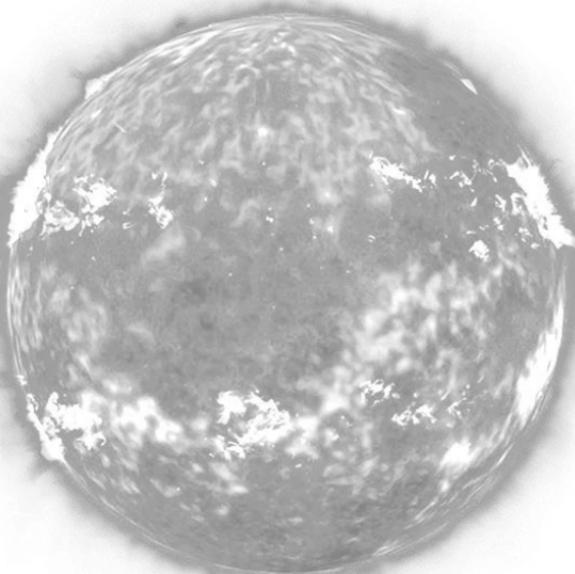
Do you know why the planetary system which we live in has been named 'The Solar System'?? Many of the remarkable names have been either derived from Greek or Latin. Talking about 'the solar system', it has been derived from Latin. Not getting how?? Let's break the solar system. It consists of the word 'sol'. Sol is the Latin name for our Sun. so anything related to the sun is called solar.

## *Formation of our solar system in a nutshell.*

Our solar system formed about 4.5 billion years ago from a dense molecular cloud that consisted of gas and dust. The cloud disintegrated, possibly due to the shock wave of a nearby erupting star named a supernova and formed a solar nebula –a spinning, rotating, and flattened disk of material. At the centre, gravity attracted more and more material. finally, the pressure in the core became so large that the hydrogen atom started combining and form helium, releasing a large amount of energy. Due to this, our sun was born.

Matter farther in the disk was also clumping together. These clumps attached into one other, forming larger and larger objects. Some of them grew big enough so gravity could act and shape them into spheres forming planets, dwarf planets, natural satellites, etc. The left material which couldn't be shaped into a sphere became asteroids, comets, meteoroids, and other irregular bodies.

*Simply Universe*



## *Simply Universe*

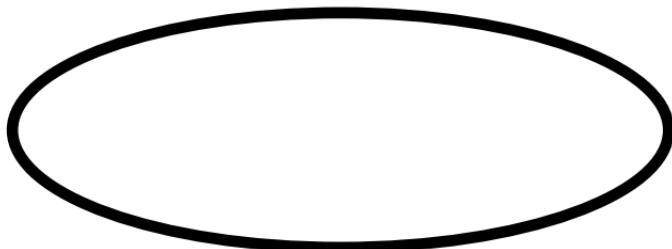
“When the sun is going down, I feel you coming closer. Counting in the dark, I feel at home.” Oh sorry, the sun made me remember ‘Aurora’, a beautiful song by K-391. You should listen to this song. I’m sure you’ll love it.

The sun is a big mass of gas and plasma situated in the centre of our solar system. It is the largest object within our solar system but still isn’t as large as other stars. Scientists have classified the sun as “a yellow dwarf star”. As you know, the sun is comparatively very large than the planet on which we live. Its diameter is around 1.39 million kilometres. And as it's very large so its mass is also very large i.e.,  $1.99 \times 10^{30}$  Kg. That is nearly 110 times more mass than that of earth. The sun comprises 99.8% of the solar system’s mass.

Sun is the most important source of energy in our solar system be its light energy, heat energy, etc. Its diameter is about 1.39 million kilometres (approx.). it has a mass of about  $2 \times 10^{30}$  kg. oh my god!! That’s a significantly large figure, isn’t it? The main constituents of the sun are hydrogen and helium. Hydrogen is the naughtiest while helium is just a shitty introvert. The distance between the sun and the planet on which we live (earth) is 149,597,870.9 Km. This is a very large figure and thus scientists have given this a very special

## *Simply Universe*

name –astronomical unit (Symbolized as AU). So, 1 astronomical unit can be defined as the distance between the sun and earth, or also it can be defined as a length of 149,597,870.9 km or just approx. 150 million km. All the planets revolve around the sun in an elliptical orbit. Elliptical orbit looks like an oval or an elongated circle.



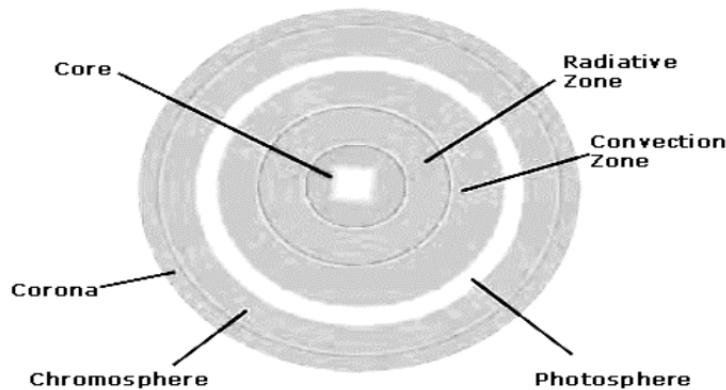
*Fig 2.2 –An ellipse*

Due to elliptical orbit, the distance between the planets and the sun keeps varying depending on the position of the planet on the orbit. Taking the case of the earth. There are two main points on the orbit which are considered and are named aphelion and Perihelion. These are the farthest and nearest point to the sun on earth's orbit and are also called apsides. The perihelion is the nearest point to the sun on earth's orbit and the distance between sun and perihelion is 147,091,144 Kms. Similarly, Aphelion is the farthest point to the sun on earth's orbit and

## *Simply Universe*

the distance between aphelion and sun is 149,597,870 Kms. That's a difference of around 2.5 million Kms. You know, light takes some minutes to reach earth from the sun's surface. So, when the sun is at perihelion, the flight takes around 8 minutes and 11 seconds (approx.). similarly, when the earth is at aphelion, light takes around 8 minutes and 19 seconds (approx.). The sun is a heavy element-rich star. The sun has six regions: The core, The radiative zone, The convection zone, The visible surface aka photosphere, The chromosphere, and the corona (Not that coronavirus!!), I just hate it).

So, let us discuss these zones.



*Fig 2.3 –Anatomy of The Sun*

Talking about the core, it is also known as the solar core. It is the region where nuclear reactions take place to form helium from existing hydrogen. The temperature at the very centre of the Sun is about 15-million-degree Celsius or kelvin (as there is just a difference of 273.15 degrees) and the density is about  $150 \text{ g/cm}^3$ . After the Core, comes the Radioactive zone. As the name suggests, the radioactive zone helps in energy transfer from the core in the form of radiation. The energy generated in the core is carried through photons through the radioactive zone. The density of this part drops down to just  $20 \text{ g/cm}^3$  at the start of the radioactive zone and further drops more to just  $0.2 \text{ g/cm}^3$ . Then further comes the convection zone. It is the outermost layer of the sun's interior. As the name suggests, the convection zone transfers energy from the radioactive zone through convection as due to the opaqueness of the convection zone, energy is unable to transfer through radiation. Here the density drops at  $2 \times 10^{-7} \text{ gm/cm}^3$ . During convection, the heat transfer takes place due to the movement of molecules within a fluid. There lies a small zone of tachocline between the radioactive zone and the convective zone. The Core, The Radioactive zone, The Convective zone, and the Tachocline are collectively known as the solar interior or internal structure of the sun. Now let's move to

## *Simply Universe*

the outer structure. Firstly, comes the Photosphere. It is the outer visible surface that we generally see.

7.

Is there  
only one  
universe?

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## Simply Universe

A multiverse is a hypothetical group of multiple universes. Together, these universes comprise everything that exists: the entirety of space, time, matter, energy, information, and the physical laws and constants that describe them.

## *Simply Universe*

In science every question or any theory is not wrong or can be falsified until there is an evidence of it being wrong. So, here is another fascinating idea that has many controversial or opposing theories we are going to dive in and scratch our heads. From centuries science has developed a lot and there so much we have known about our universe, yes there is a lot more to explore but there also a mind-boggling question that can there be other universes? and do we have evidence for it?

My friend there is no such evidence of what Einstein predicted about inside of a black hole, but we do accept it right! Because we cannot go inside it ... come back and publish about what is in there, so we simply accent the theory or prediction whatever you call it. Similarly, there is no evidence but there are theories which are widely accepted and theories which are ignored. Keep your mind open and accept the ideas of multiverse even if you contradict it.

Let us start with the most accepted one first. But the third one is the most fascinating one for me.

## *Simply Universe*

### *The Level 1 Multiverse*

The universe we can observe is called the observable universe. we are not using telescope to see it but recording the gravitational waves and the light coming from them defines the boundary of our observable universe. According to Physicist Max Tegmark, the space is infinite, with no end, no boundary. Outside our observable universe there starts a new one with the same size and same physics (laws, constants, etc.) but there the origin of their universe might be some other phenomena, so somewhere in that universe the schools might teach the same physics, but the history would be different. There is a single evidence of existence of these kinds of worlds: the WMAP (Wilkinson Microwave Anisotropy Probe) launched on 1 July 2001, 1:16 am IST in the outer space which today is 1.5 million km away from earth. The WMAP has sent some readings that in past our universe might have colluded with any other universe. So, if it has collided with something then it means that it exists. So, given infinite space, there would, in fact, be an infinite number of Hubble volumes identical to ours in the

## *Simply Universe*

universe. This follows directly from the cosmological principle, wherein it is assumed that our Hubble volume is not special or unique. And yes! You can travel to these kinds of parallel universes if possible.

## *The Level 2 Multiverse*

According to Max Tegmark this multiverse is a more diverse and complex as it contains a chaotic version of inflation theorized by Andrie Linde. But we are gonna make it simple to understand. Here it's hard for life to exist because according to scientist this kind of universe has different physical constants which leads to a big trouble for ex: if the amount of dark matter is different than what is in our universe then the formation of galaxies will not be possible and ultimately the solar system will be dead. And if the Higgs particle has some different fluctuation, then the atoms might not exist, just imagine that world where there see no atom and see ours, everything is made of atom. At the same time there is possibility of a universe where we can get all physical constants similar, but the laws might have a difference, thus the students there would be studying totally different

## *Simply Universe*

history of universe as well as physics. One more interesting fact can be that these kinds of universes might have other dimensions or might have lesser than ours. This prediction of multiverse gave someone a Nobel prize, not directly though. It led Fritz Zwicky to discover DARK ENERGY. For travelling to this kind of universe we might need a black hole but even if we find a way to get there I would never prefer to because if somehow, I accidentally enter a universe with differing Higgs particle where existence of atoms is not possible I, who is made up of atoms all over would no longer exist.

## *The Level 3 Multiverse*

This includes quantum mechanics and this one is the most successful theory of all, but it costs some weird ideas, it suggests that a particle can be at different places at once. I am made of particles so can I be at different places at once? No, researchers in MIT discovered that what this idea actually means that there is a third kind of parallel universes, where we make certain decisions and effectively our world splits into several tracks or simply if you have to choose 1 shoe out of 5 the world splits into 5 different

## *Simply Universe*

world, here spilt does not means breaking into parts but actually means that a new one is created identical to ours but there you bought a different shoe than what you have bought in yours and once a new world gets formed because of different possibilities the new one continues parallel to ours. Yes, you are thinking correct in one of our parallel worlds you crush is in relationship with you even if he/she has slapped you in yours.

This is the same thing what can actually save Schrodinger's cat. Do you know about Schrödinger's cat?? Wait let me tell you about it.

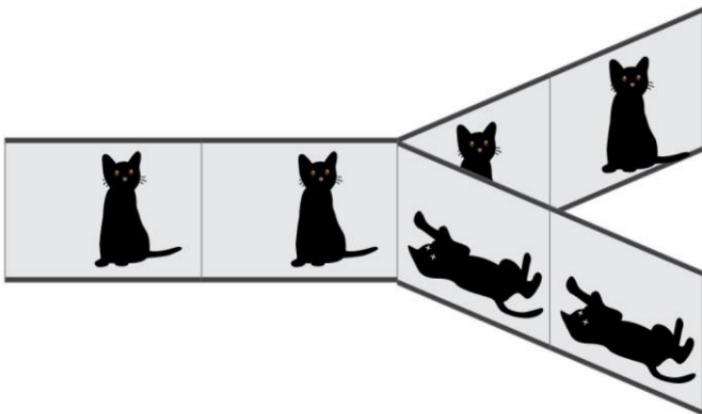
### *Schrödinger's cat*

Schrodinger did a thought experiment in which a cat was put inside a box with a dangerous radioactive element which can kill it if the glass container gets broken but it has half probability of getting so.

Now without opening the box you can't tell whether the cat is dead or alive so we assume that it's in both the condition 50% dead and 50% alive, once you open the box a new universe is created simultaneously in which the cat is just

## *Simply Universe*

opposite of what it is in your universe, it's like it is dead in your universe but in a newly created world it is alive.



*Fig 2.3 – Schrödinger's cat experiment*

## *Level 4 Multiverse*

This is a sort of mathematical stuff but let me tell you what it actually means. It tells that there are parallel universes around us with some minor or major differences but  $10^{1180}$  meters away from our universe there exist another identical parallel universe where literally everything is same even the level of development, life, science, etc.

8.

Transforming  
into  
interstellar  
species

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## *Simply Universe*

We say the sky is the limit,  
But rather it isn't.  
It is our gateway to  
Limitless opportunities.

## *Simply Universe*

As a species, we humans have developed a lot, everyday something new is being created which is making our life easier and helping us grow and get more advanced as a civilization. Whatever the situation may be, we have come up with something. In the initial days, 5 to 6 million years ago when humans first evolved, the question was of survival from the danger of other lifeforms, with gradual advancements, the questions have always changed- getting on the top of the food chain, protecting similar ones, ruling the world, and now in the present era and near past; supremacy, environment, freedom, culture and tradition, sciences, research, space exploration, extraplanetary missions. We have reached from starving for food to reaching the nearby planets, and even space agencies such as SpaceX and NASA are planning to send humans to Mars, which is one of the most habitable planets after Earth in our solar system in nearby future and this will be the first step towards colonizing space and becoming an interstellar species. now let's talk about how would it look like when humans will become an interstellar species.

Reaching nearby planets will not be a big deal it would be like a holiday vacation hot spot for

## *Simply Universe*

us and that's what SpaceX' CEO Elon Musk wants that we could buy tickets to travel into space in the upcoming future just like we buy tickets for aeroplanes, but being an interstellar species means a lot much bigger things and not only colonizing but also making a liveable planet for us will also be a major project. Massive spaceships will be deported from our new planetary bases to far away planets in other solar system or even galaxies which obviously means that it would take a lot of time which is much more than life cycle of humans so spotting a hibernation pot will not be a big deal at that time as we see in nowadays science fiction movies. We will be able to explore new species which may be 1000 times or a million times more advanced than us or may just have started evolving into an intelligent species.

But will this be so smooth as it seems to be? definitely not! because just imagine if an alien species invades our planet even for good reasons, we will definitely try to resist their invasion similarly if we try to enter the region of more intelligent and more advanced species, it would be really hard to cooperate with them, this would lead to massive wars in space, just imagine

## *Simply Universe*

how fascinating it would look like but sorry you won't be able to experience that as it would take more than 2.5 million years from now, statistically it will take us 7000 years to reach the nearest star **Proxima Centauri** .

So, all this is a very slow process and with this speed it would take a lot of time for us becoming interstellar species.

Ever thought of the modes of transportation in the future! obviously not more than a flying car right! But believe me there will be highways between planets, obviously not the types of one we have now, they will be megastructures which will be deformable, reformable, non-destructible and accessible to everybody so yes in the near future you can buy a ticket to visit Mars but after millions of years in human species probably every human would be having a personal space jet to travel between planets.

## *Simply Universe*

### *What would Mars and Moon look like after 500 to 1000 years?*

Moon would have become earth's launch base and parking area for spacecraft and rockets. Skilled mechanics will be living there for their lifetime for the purpose of repairing and managing these spacecrafts with the AI enabled robots in support.

By this time Mars will have become our second home and thousands of kids would have been born in 3D printed hospitals on the Red Planet, and now the new passports will start including "the planet of birth" too. On Mars the population would have grown to at least 1,000,000 with more than half of them who got birth there and still living on the planet, the body design of these people will be a slightly different from us, they will be taller than us and their bones will be at least 0.5 times weaker than ours due to the gravity difference. But still it would take a million more years to terraform the Red Planet with plants and oceans until then we would have to live in 3D printed domes and travel underground because surface is so unpredictable that travelling under the land

## *Simply Universe*

surface will probably be the best option. Hopefully Elon musk's boring company will be the one building tunnels for the first time on the planet.

### *Contacts with other Interplanetary and Interstellar Civilization*

A fascinating topic which I want to discuss in this chapter are UFOs and alien civilization. There are many people who claimed to have sucked up by indistinguishable spacecraft and then left back after some time, there are so many photographs and video clips of UFOs appearing and disappearing with a great speed today's technology cannot match with. The very famous **Area 51** is said to be the place where aliens have been in contact with humans for several years now, but definitely this is not something to tell everyone about because imagine this news coming out, people around the world will go mad and start praising these alien species as gods who arrived from heaven and that's the most unwanted thing - making new superstitions and dominating actual science. Not everybody agrees with these phenomenon but in my opinion the

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idea that aliens have been visiting us since so many years and the abduction stories are probably true because practically this should be true, there are billions of planets out there in our own Galaxy , millions of earth like planets would have evolved billions of years before our earth and probably have an intelligent species within it which got a lot more time than us humans to develop and advance its technology, so by this time there would be an alien species hovering around the empty space searching for another life forms and some would have even found us but why aren't they making public contact? Why aren't they starting to cooperate, share resources and technology? For sure the reason can be that they are waiting for us humans to develop more mature as a species and take our mentality to a bigger scale because I don't think that someone out there would be faking these UFOs and the pictures these videos clips and what about those humans, all having the same story from different parts of the world given the same description about their experience when they were sucked into these UFOs.

The present superpower United States of America is not a fool to invest billions of dollars

## *Simply Universe*

in agencies like Pentagon, which have main objective of researching on these unidentified flying objects. There was no need right now to have plans about having deadly missiles in space for planetary protection, what are they protecting the planet from?

The USA is not the only country that funds research on extra-terrestrials but countries like **Brazil, Canada, Denmark, France, New Zealand, Russia, Sweden and United Kingdom** have been declassifying their X files since 2008. The French committee which examined spaceship sightings in late 2000s noted that 5% of alien encounters are reliable. In 2017 Chile released a video clip taken from a shrink footage of a close alien encounter but soon it was banned from getting displayed in media after getting pressure from UN. In middle 1950s America established **Project Blue Book** which assumed that around 50,000 alien sightings and encounters and human abductions took place and that was nearly 70 years ago. By this time the number would have increased in multiple of 10s or hundreds. Hearing that interview of President Barack Obama about UFOs in which he was asked about whether UFOs are real things! He

## *Simply Universe*

replied, “can’t tell” (in a serious gesture, like it was something top secret) how can someone take this thing so easy.

India has even become a case study in UFO, **The Great Himalayas** according to conspiracy theorists is a UFO base. in 1964 a famous UFO researcher **Billy Meyer** travelled to India and short a series of photos of spacecrafts in Delhi skies and also reported a regular appearance of these spacecraft in Konko la which is a disputed area between India and China and what is the site of fierce battle 1962.

A very fascinating story of 2004, a team of five members from ISRO were camping in some geological side near Uttarakhand to study the Chandra basin glacier. At about 6:45 AM one of these highly qualified scientists who was examining the mountain ridges ran back to his team screaming about a floating object hovering 3 to 4 feet above the ground and a robotic object walking around there, and guess what they definitely took pictures- lots of pictures of that thing, the strange object had a head with two balloon shaped attachments to the body, hands and two legs, and it seemed to be walking and

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pacing its steps like a human being. Later tests even confirmed that the scientists were not suffering from any sort of high-altitude hallucinations. After more such sightings taking place in that region occurred this became a big thing, and after in 2013 a spacecraft was reportedly observed flying above the taj mahal, this news now was confirmed by the prime minister's office, and this also got a written reply from the parliament and confirmation to start a full-fledged investigation on this.

All what I want to convey is that we are not alone and it is not the case that you humans have not been found by another intelligent species, but nobody knows what is the actual reason these unidentified flying objects add observing us without any contact. There are equal chances that in future we would have to battle another life form for our survival and for claiming our resources but a more advanced and a more mature species which would have taken a lot more time to develop this certain level where we have not reached will never think of a battle because probably they might be having experience of having a battle and seeing its level of destruction for both the species, so here we

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have a peaceful edge for our future because already a higher civilization is observing us and maybe at a certain time they will definitely make contacts with humans and cooperate by sharing resources technology and other stuff.

9.

Paradox'



*Simply Universe*

## *What is a “paradox”?*

Ever heard of something that seems impossible or very hard to understand but on the other hand it may be true?? This is only called a paradox. A paradox consists of self-contradictory statements which are difficult to understand but in reality, expresses a possibility.

Let's understand this with an example. "A square is also a rectangle". Forget your previous knowledge and just focus on this. On the first instance you will think that how can a square be a rectangle. This kinda seems impossible. But if we further try to compare the definition of rectangle i.e., a figure whose opposite sides are equal and perpendicular to each other and the definition of square i.e., a figure wh

ose all the sides are equal and perpendicular to each other, we can see that a square is indeed a rectangle because its opposites are equal to each other and also perpendicular to each other. Let's take one more example but a more logical one.

The following sentence is true.

The above sentence is false.

Now try to understand this simple yet little bit of logical paradox. I will not be explaining this one!! Let's see some popular paradoxes on the next page.

## *Simply Universe*

### *Polchinski's paradox*

In simple words, polchinksi's paradox is all about going in past and preventing an action which lead you to go in the past. Imagine your girlfriend enters a wormhole and travels back in time to the moment when she was about to enter and prevent herself from entering the wormhole, in the first place. What will happen next!!!

Let me explain it using one more analogy, the billiard ball one. A billiard ball enters a wormhole and travel back in time to the moment when it was just about to enter the wormhole and collide with the ball entering at that moment and prevent it from entering.

### *Predestination paradox*

In simple words, Predestination paradox is all about travelling back in time to prevent an accident from happening, but finding yourself to be the one who caused that accident in the first place.

Suppose your friend XYZ died in a car accident. You went back in time to prevent this car accident. To reach the accident spot on time you rashly drove and caused the same car accident which you wanted to prevent. This means that you were the person who caused this accident. MURDERER HUH!!

## *Incident paradox*

This will somewhat trick your mind. This paradox is all about travelling back in time and preventing an incident, since you prevented the incident from happening, the incident will not happen which will prevent yourself from travelling back in time to prevent the incident in the first place.

## *Time Traveller's paradox*

Imagine that you met a time traveller and he gave you a time machine, further you used that time machine to go further in time and kill the time traveller even before he invented that machine.

## *Bootstrap paradox*

Let's understand this paradox using an exciting example. Suppose you travel back in time and teach Newton his laws of gravitation even before he himself discovered it. Oh shit!! This means that the laws of gravitation have no origin. Woah!

One more. Imagine you read this book and somehow you travelled back in time and came to me to give me the contents of my own book even before I've started writing this book.

I'm sure that you have understood this paradox.

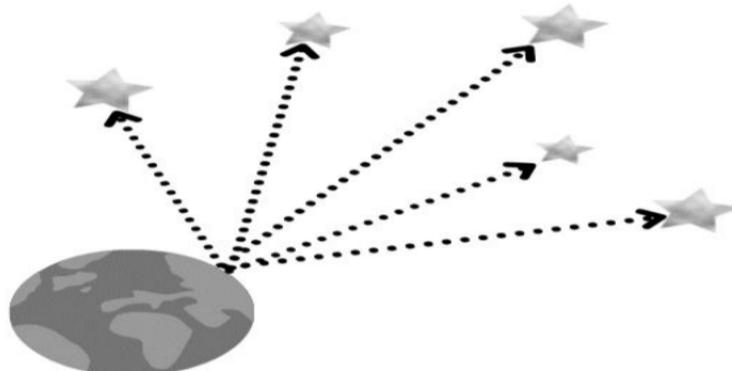
## *Simply Universe*

### *Grandfather's paradox*

Build a time machine. Go back in time using the time machine, kill your grandfather even before your parents were born. So now your grandfather is dead. Now your father will not be born and you will also not be born but you are already here. Surprised?? This paradox creates many problems for people thinking time travel is possible!!

### *Olber's paradox*

Why is the sky black? As per the steady state theory, our universe is infinite, static and timeless. So, wherever we look in the sky, eventually our eyes must be hitting a star but then too our sky appears black. Now it turns out that our universe is neither static nor timeless. Edwin Hubble discovered that the universe is expanding as discovered in a previous chapter.



## *Simply Universe*

### *Fermi's paradox*

Where is Everybody?? Why aren't we meeting aliens?? There are billions of stars in our milky way galaxy. Millions of them must be having their planetary system and planets like earth. So, there should be millions of alien civilisations in the milky way, but still, we are unable to find one.

## *Simply Universe*

### *Zhuang Zhou paradox*

You're dreaming that you're a butterfly hovering here and there. Suddenly you woke up and no longer know if you are a person who dreamed of being a butterfly or if you are a butterfly dreaming of being a human. Well, I would believe that I am a butterfly dreaming of being a man. What are your thoughts?? What would you prefer?? Write it below!!

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10.

Time

to

overthink

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## Is earth's gravity uniform??

So, you might think that earth's gravity is uniform everywhere or you might have read it in your textbooks that acceleration due to gravity is  $9.8 \text{ m/s}^2$  everywhere on the earth. But that not's the case. Earth's gravity is non-uniform. Confused?? Let me explain this to you.

But first I will tell you how acceleration due to gravity is calculated. This will help you understand better. ***The acceleration experienced by a free-falling body due to the gravitational force of the mass body is called acceleration due to gravity.*** This value depends on the mass of both the bodies and the distance between them. Let's calculate the value of acceleration due to gravity on earth at Sea level.

$$g = GM/D^2$$

(Where  $g$  is acceleration due to gravity,  $G$  is universal gravitation constant having a value of  $6.674 \times 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2}$ ,  $m$  is the mass of earth i.e.,  $5.972 \times 10^{24}$  and  $D$  is the distance between the centre of earth and its surface at sea level i.e. (the radius of earth) 6371000 metres)

## *Simply Universe*

Now,  $g =$

$$(6.674 \cdot 10^{-11} \cdot 5.972 \cdot 10^{24}) \div (6371000)^2 \text{ m/s}^2$$

Which is equal to  $9.81953203 \text{ m/s}^2$ .

Okay so, now we will calculate the value of  $g$  while we are standing on mount Everest.

$$g = GM/D^2$$

(Where  $g$  is acceleration due to gravity,  $G$  is universal gravitation constant having a value of  $6.674 \cdot 10^{-11} \text{ m}^3 \text{ kg}^{-1} \text{ s}^{-2}$ ,  $m$  is the mass of earth i.e.,  $5.972 \cdot 10^{24}$  and  $D$  is the distance between the centre of earth and tip of the mount Everest i.e. (the radius of earth + height of mount Everest from sea level)  $6379849$  metres)

Here,  $g =$

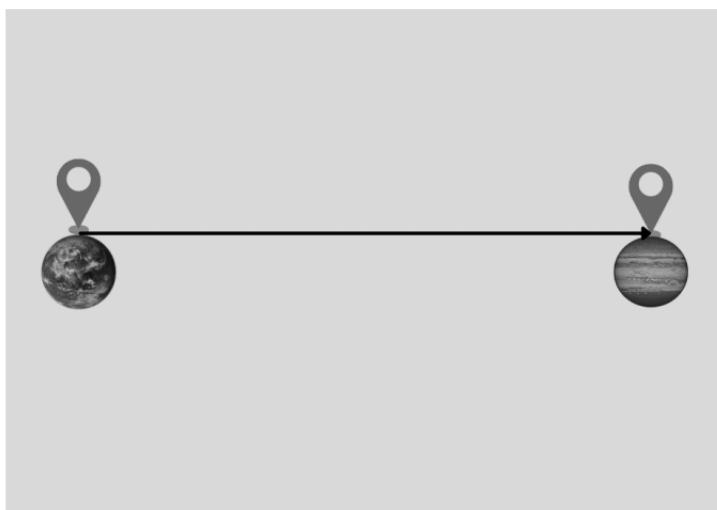
$$(6.674 \cdot 10^{-11} \cdot 5.972 \cdot 10^{24}) \div (6379849)^2 \text{ m/s}^2$$

Which is equal to  $9.79231108 \text{ m/s}^2$ . Surprised?? So, no you've got to know that  $g$  is not the same everywhere. Still this is a negligible difference for high school level problems so no worries.

## *What is a wormhole??*

You might have come to know about wormholes through any science fiction movie like interstellar. Well, if you haven't Seen interstellar yet then you're committing a crime. Go and watch it as soon as possible. So, let's start our discussion of wormholes.

Just imagine you have a sheet of paper with a love note written on it. Now assume that one point of the paper as earth and subsequently Another point as Jupiter as shown below.



Now if you want to go from Earth to Jupiter then here simply you can walk from earth to

## *Simply Universe*

Jupiter following the line given in the picture. Well here that's the shortest path between earth and Jupiter. You still think the same?? well that's now the shortest. Let me explain it. Fold the paper in such a way that both earth and Jupiter connect to form a same point. Let's name this point as X.



As you can see here that now the shortest point between earth and Jupiter is Through point X. Now you only have to travel through the point X to reach Jupiter almost instantly. Well in Astrophysics this point X is called a wormhole. It's a shortcut between two separate point in space time. It is also known as Einstein-Rosen Bridge. We may not have seen wormholes but they could be certainly out there.

Simply Universe

# What will happen if earth suddenly stops rotating??

(You will have to answer this. The best ones will be featured in the next edition. Mail it to us on contact@yashsharma.gq)

11.

Some  
Terms

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*Simply Universe*

## *Simply Universe*

**Acceleration** – Rate of change of velocity of an object with respect to time. It is denoted by “**a**”.

**Anti-Matter** – Matter composed of antiparticles.

**Antiparticle** – A counter part of subatomic particles having opposite properties.

**Anti-Neutrino** – Subatomic particle with no charge or mass. These are emitted in beta decays.

**Astronomical Unit** – The distance from earth to the sun. It is equal to approx. 150 million kilometres.

**Black Hole** – A region of spacetime where gravity is so strong that no particles or even electromagnetic radiation such as light can escape from it.

**Boson Particles** – A particle that follows Bose-Einstein's statistics.

**Centre of Gravity** – A hypothetical point around which the force of gravity appears to act.

**Centre of Mass** – A point at which whole of the mass of the body or all masses of a system of particle appear to be concentrated.

**Centre of Rotation** – A point around which a plane figure rotates.

## *Simply Universe*

**Conservation of Energy** – Energy can neither be created nor be destroyed, it can just be transformed from one form to another.

**Conservation of Mass** – Mass of an object or collection of an object remains constant. It never changes. The mass of whole universe is constant.

**Convection** – Transfer of heat due to bulk movement of molecules within fluids.

**Cosmic Ray** – High energy nuclear particles apparently originating from space and moving with speed of light.

**Density** – Mass of a substance per unit volume.

**Doppler Effect** – The apparent change in the frequency of a wave due to relative motion between the source and the observer.

**Doppler Shift** – Change in wavelength due to relative motion of source and detector.

**Electromagnetic Radiation** – Electromagnetic radiant energy carried out by electromagnetic waves throughout space.

**Electromagnetic Waves** – Waves that are created as a result of vibrations between an electric field and magnetic field.

**Electrons** – An electron is a subatomic particle which is negatively charged and carries a charge of -( $1.673 \times 10^{-19}$ ) C.

## *Simply Universe*

**Emissivity** – The ratio of radiant energy leaving a surface to that of a black surface at the same temperature and with the same area.

**Energy** – Quantitative property which is capable of causing changes in matter.

**Energy Density** – The amount of available energy per unit volume.

**Energy Level** – Different orbits around nucleus in which electrons revolve.

**Entropy** – (i) Measure of disorder in a system.

(ii) Ratio of thermal energy to unit temperature that is unavailable for doing useful work

**Equilibrium** – Condition in which the resultant force is equal to 0.

**Escape Energy** – The minimum amount of energy given to a body from the surface of the earth so it escapes from the earth's gravitational field and never returns back.

**Escape Velocity** – The minimum velocity given to a body from the surface of the earth so it escapes from the earth's gravitational field and never returns back.

**Evaporation** – Change of water from its liquid state to its vapor state using surrounding's heat energy.

**Excitation** – The addition of discrete amount of energy in a system.

**Excited State** – A state in which a system has higher energy than the ground state.

**Fission** – A process in which the nucleus of an atom splits into two or more smaller/lighter nuclei.

**Fluid** – Substances/matter that can flow i.e., liquids, gases and plasmas.

**Force** – A push or pull that tends to change the state of motion or state of rest of a body.

**Force of Gravitation** – A force of attraction acting between two masses.

**Frame of Reference** – Set of coordinates that are used to determine the position and velocity of an object in that frame.

**Free Fall** – The motion of a body under the effect of gravity only.

**Freezing Point** – The temperature at which a liquid starts to change to its solid state.

**Fundamental Particles** – Subatomic particles that do not have a substructure. Those particles of which all materials are composed of i.e., quarks and leptons.

## *Simply Universe*

**Fusion** – A process in which two or more nuclei are combined together to form one or more different nuclei with the release of energy.

**Gravitational Field** – The region around a gravitating mass where it's gravitational influence can be felt.

**Gravitational Force** – The force of attraction between two masses.

**Gravitational Interaction** – The interaction between particles of matter that has no known distance limitations.

**Gravitational Mass** – The mass of a body as measured by its gravitational attraction for other bodies.

**Gravitational Potential Energy** – The energy acquired by an object due to change in its positions (height) when it is present in a gravitational field.

**Graviton** – Hypothetical particles that carry the gravitational force.

**Gravity** – It is the force of attraction acting between bodies having either energy or mass.

**Kepler's First Law of Planetary Motion** – All planets move in elliptical orbits with the sun at the focus.

**Kepler's Second Law of Planetary Motion –**

The line joining a planet to the sun sweeps equal areas in equal time, in other words, the areal velocity of all the planets remains constant.

**Kepler's Third Law of Planetary Motion –**

The square of the time period (time taken to complete one revolution) is directly proportional to the cube of average distance of the planet from the sun.

**Law of Conservation of Energy –** In a closed/isolated system the total energy remains constant. Energy can neither be created nor be destroyed, it can just be transformed from one form to another.

**Law of Heat Exchange –** It states that heat can only be transformed from a hot object/body to a cold object/body where the heat lost by the hot object/body will be equal to the heat gained by the cold object/body.

**Lepton –** Particle that interacts with other particles only by the electroweak and gravitational interactions.

**Light Year –** The total distance travelled by a beam of light in a year.  $1 \text{ light year} = 9.461 \times 10^{15} \text{ meters}$ .

**Mass –** The amount of matter contained in a body.

## *Simply Universe*

**Mass Density** – Mass per unit volume of a substance.

**Matter** – Anything which has mass and it occupies some space.

**Matter Wave** – Wave like properties shown by particles such as electrons and photons.

**Melting Point** – The temperature at which a substance changes from its solid state to liquid state.

**Meson** – Medium massed subatomic particles containing one quark and 1 antiquark.

**Neutrino** – A subatomic particle that is very similar to an electron but has no electrical charge and a very little mass. It is a type of lepton.

**Neutron** – A subatomic particle with no net electrostatic charge and has a mass slightly higher than that of proton. It is a type of nucleon.

**Newton's Law of Gravitation** – It states that gravitational force between two bodies is directly proportional to the product of their masses and inversely proportional to the square of the distance between them.

**Nuclear Binding Force** – The force that acts within the small distances between nucleons.

**Nuclear Energy** – The energy released during the splitting of nucleus.

**Nuclear Equation** – An equation representing a nuclear reaction.

**Nuclear Fission** – A reaction in which large nucleus splits into small nuclei which are often equal in masses.

**Nuclear Force** – The strong force which acts between two nuclei or between protons and neutrons.

**Nuclear Fusion** – A reaction in which two or more nuclei combine to form one or more atomic nuclei or subatomic particles.

**Nuclear Reaction** – A process in which two or more nuclides are produced from the collision between two atomic nuclei.

**Nuclear Transmutation** – Change of one chemical element to another chemical element.

**Nucleon** – Subatomic particles present inside nucleus i.e., Either proton or neutron.

**Nuclide** – Nucleus of an isotope.

**Nucleus** – The central positively charged and dense part of an atom around which electrons rotate.

**Orbit** – The region around any planet or star where an object is held in circular motion due to the gravitational force.

## *Simply Universe*

**Orbital** – The region around a nucleus where an electron is likely to be found.

**Photoelectrons** – Electrons emitted from a light sensitive material when it is illuminated with light of sufficiently short wavelength.

**Photons** – It is a subatomic particle that carries electromagnetic force is the quantum of electromagnetic radiation.

**Plasma** – A state of matter in which atoms are separated into electrons and positive ions or bare nuclei.

**Positron** – Antiparticle equivalent to electrons.

**Proton** – A subatomic particle carrying a positive charge and is present inside the nucleus of an atom.

**Quantum Mechanics** – A branch of mechanics that deals with the study of matter using its wave properties.

**Quark** – Fundamental particles of matter. Building blocks of protons, neutrons, etc.

**Radiation** – Energy given out by matter which is transmitted in the form of wave energy without any material medium.

**Reference Point** – Something that is used to compare something else.

## *Simply Universe*

**Relativistic Mass** – The mass of an object in motion with respect to observer.

**Rest energy** – Energy possessed by an object due to its mass.

**Rest mass** – Mass of an object which is at rest i.e., it is not in motion

**Trajectory** – The path followed by projectile.

**Triple Point** – The temperature and pressure at which the solid, liquid and the gaseous phase of a substance can coexist in stable equilibrium.

**Uncertainty Principle** – It states that it is impossible to simultaneously specify both the position of an object and its momentum.

**Universal Gravitational Constant** – It is the constant of proportionality in Newton's law of gravitation which is equal to  $6.673 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$  and its symbol is 'G'.

**Universal Law of Gravitation** – It states that the gravitational force of attraction between any two particles is directly proportional to the product of the masses of the particles and is inversely proportional to the square of the distance between the particles. The direction of the force is along the line joining the two particles.

## *Simply Universe*

**Volume** – The amount of space occupied by an object or substance.





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[www.simplyuniverse.cf](http://www.simplyuniverse.cf)

We had left the solar system Chapter incomplete.  
Sorry for that Hehe.